Evaluation of Continuous Marking Menus for Learning Cursive Pen-based Commands

Peiyu Li, Adrien Delaye, Eric Anquetil

Evaluation of Continuous Marking Menus for Learning Cursive Pen-based Commands

PeiYu LI, Adrien DELAYE and Eric ANQUETIL
INSA de Rennes, Avenue des Buttes de Coësmes, F-35043 Rennes
UMR IRISA, Campus de Beaulieu, F-35042 Rennes
Université Européenne de Bretagne, France
{Pei-yu.li, adrien.delaye, eric.anquetil}@irisa.fr

Abstract. We present here the Continuous Marking Menus, which help users learning a set of handwritten commands on a pen-based interface. The aim of this paper is to experimentally attest the interest of this new type of menu by evaluating its ability to help the learning of a set of gestures. We describe an experimental comparison on the task of learning a set of gestures with or without the help of Continuous Marking Menus, and we conclude that with the help of Continuous Marking Menus, people learn more easily the gestures.

1. Introduction

Pen-based interfaces have made a big success these years thanks to their capabilities to make users realize their commands with the help of a stylus. In general, we associate a significant gesture (which respects some relation understandable for users) to every command in order to ease the memorization for users (Rubine, 1991; Willems & al., 2009). For example, a "C"-shaped gesture can be associated to the "Copy" command; or a "V"-shaped gesture to the "Paste" command. Despite these efforts for associating "intuitive" gestures to commands, learning gestures can remain a tedious task for the users, especially if the number of gestures is important. That's why marking menus have appeared as an alternative to help people learn gestures (Kurtenbach, 1993).

Marking menus are advanced forms of radial menus that are popped-out according to the user needs. They permit two states of utilization: *novice state* in which the menu is displayed to guide the users, and *expert state* where the users have already implicitly learnt the commands and the system behaves like a traditional gesture-based interface with a recognizer to associate a command to an input gesture. The idea of marking menus is that by using frequently the menus in novice state, the physical movement to choose a command can be associated to the command's gesture, so that the users will learn by heart implicitly the gestures for the expert state. The basic form of marking menus is non-hierarchical, and only permits simple radial gestures from menu center toward a chosen direction. Hierarchical versions exist too, such as flower menus (Bailly, 2009), zone and polygon menus (Zhao & al., 2006), etc.

Among these studies, simple marking menus (Zhao & al., 2004) that are constructed with several straight strokes for each command permit a larger set of commands with an acceptable error rate (like zone and polygon menus). But a big disadvantage is that the gestures produced are neither natural nor continue. This is in contradiction with the rule of fluidity of handwritten gestures. The existing variants of marking menus just offer a very limited vocabulary of gestures. Continuous Marking Menus were specifically designed so as to define a set of varied, rich cursive gestures, and to induce the user to draw them in a natural, cursive, less constrained way. In this paper, we describe at first the Continuous Marking Menus and their novelties in both topology and interaction behavior. Secondly we present an experiment that we have developed to evaluate this work in order to prove the Continuous Marking Menus' efficiency in helping the learning of gestures. The aim of this paper is to verify if Continuous Marking Menus induce a better memorization of the gestures.

2. Continuous Marking Menus

We recently introduced Continuous Marking Menus[1] as a new technique for helping users learn a set of handwritten commands, and thus for easing the process of familiarization with a pen-based interface. As in Marking Menus, the idea is to help users memorize gestures by letting them use repetitively a trajectory-based menu, in which the path required to select an item with the pen is similar to the gesture associated to the corresponding command. This process permits to move from novice state to expert state by an implicit learning of the gestures (Delaye & al., 2011).

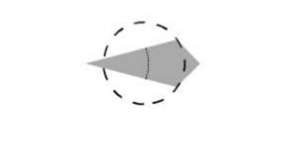
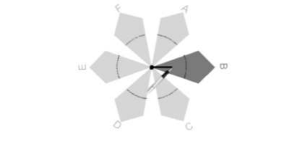
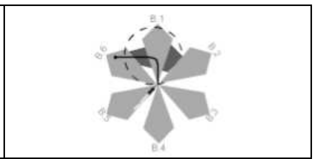
Continuous Marking Menus were specifically designed so as to optimize the shape of resulting gestural commands, allowing learning a set of cursive, fluent, less constrained gestures that are likely to be more natural for the expert user to draw. They are based on hierarchical marking menus with a choice of 4, 6 or 8 items per level (breadth). For each level, the items are represented like kites that are centered on the cursor. To obtain better trajectories of every level, we add an inactive blank zone between two neighboring branches. Between two successive levels of menus, we force an angle shift by rotating the menu to avoid ambiguity problems.

---

[1] You can find the video on our website: http://www.irisa.fr/imadoc/CMM.html

For the novice state, Continuous Marking Menus interact with people throughout the gesture with continuous feedback, which is different from other marking menus proposed before. We also add the notion of "inertia zone" which gives user more freedom when he passes from one level to another. It improves the continuity and fluidness of gestures during novice state. The menus offer two interaction areas: pre-selection area and inertia area (Table 1). In the pre-selection area of an item, the other items of the same level disappear gradually, as the cursor moves into the chosen item's branch. Once the cursor enters the inertia area, the actual branch is selected, other branches are completely faded out, and the sub-menu appears. The center of the sub-menu follows the pen across the inertia area. Finally when the cursor leaves the inertia area, the sub-menu is fixed and a new cycle begins. Figure 1 illustrates the sequence of menus to choose the item "France" from branch "Europe".

Table 1. Interaction areas.

			
...... pre-selection area ------ inertia area	Branch pre-selection	Entering inertia area	Leaving inertia area

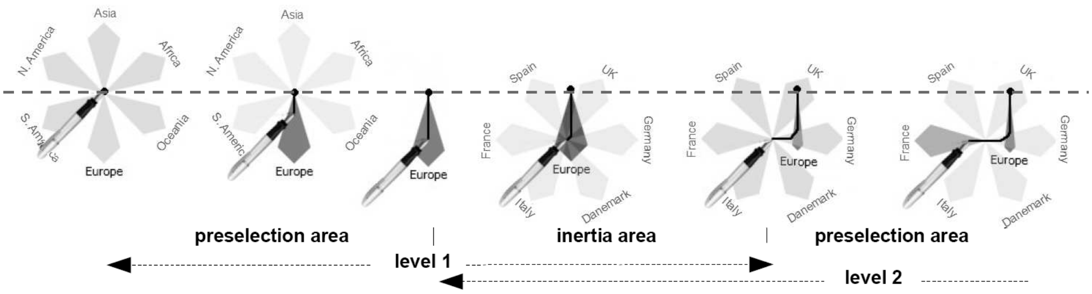


Figure 1. Steps for menu selection.

For the expert state, no visual interaction is offered to the user during the execution of his gesture. At the end of his gesture, it is analyzed by a classifier based on a Dynamic Type Warping (DTW) distance (Vuori, 2002). The principle is to compare user's stroke to prototypes of each gesture. The recognized command (i.e., the command whose prototype is the closest to the input stroke in terms of DTW distance) will be executed.

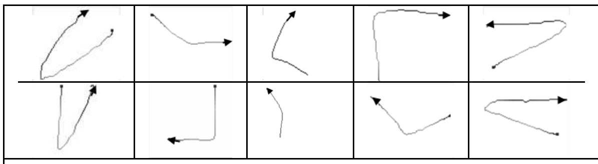
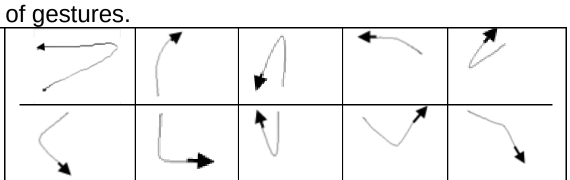
3. Evaluation

3.1. Subjects and material

Our aim here is to prove that people learn more easily the command gestures with the help of Continuous Marking Menus. Although in reality, people learn implicitly the commands with menu guides, we cannot make an experience in a short time to show this aspect. So the gestures here are learnt by heart for the two sides.

We made two memory games with 10 gestures for each (see Table 2). Every gesture corresponds to a country. To reduce the difficulty of the test, the menu is limited to a 6-breadth and 2-depth menu, which induces a set of 36 gestures in totality.

Table 2. Table of gestures.

	
Gesture set for the first test (test1)	Gesture set for the second test (test2)

12 persons have participated in this game. They are separated into two groups: one did test1 without menus (group A); the other did it with menu (group B). To reduce the bias caused by people, the two groups took turns (i.e., group A passed test2 with menus and group B passed test2 without menu). Test2 was done at least two days later so that they cannot be influenced by test1. For test2, the gesture sets and the logic organization behind the Continuous Marking Menu were changed to prevent group B from guessing the logic when they pass to test2. For the same test with or without menu, people have to memorize the same set of countries and the same

set of gestures, but for the one without menu, we mixed the correspondence between one country and one gesture to avoid users trying to guess if there is a logic behind. This is to make value of menu's advantage with its organization of commands. The menu's logic for test1 is to choose at first the continent then the country. The menu's logic for test2 is to choose at first the first letter of the country's name then the country.

3.2. Procedure

Before getting started, several persons except these 12 users who did the test have participated to a pre-test and given us some advices for interface ergonomics.

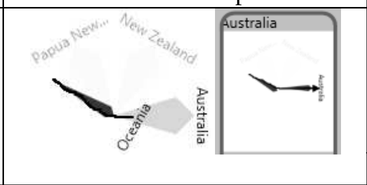
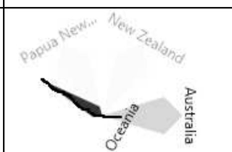
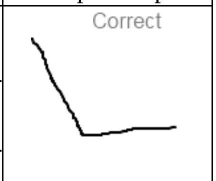
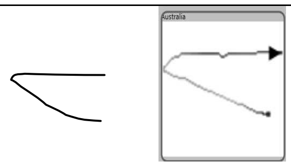
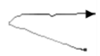
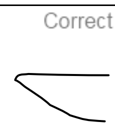
To emulate the real utilization of menus, we introduce three steps for the test: novice, intermediate and expert. A person can make 60, 50 and 50 strokes according to the novice, intermediate and expert step respectively. For the novice step, every country is asked six times in order to ease the memorization. For the other two steps, the commands are asked in a random order. Every test took about 15 minutes.

Tests with the menu. For the novice step, the user has the menu displayed all the time to guide him and also an image by the side to show how the gesture should look like. For the intermediate step, he can have the menu displayed if a low initial speed is detected. Otherwise, he is considered to master the command, so the menu is not shown and the gesture is sent to the recognizer. The recognized command will be presented to the user associated to a warning to tell him if it is wrong. He can find the gesture's image whenever he wants by clicking on "Help". Finally for the expert step, no help will be available. He is asked to draw gestures for the 10 commands for several times, in a random order. The recognizer analyzes every stroke; a message is displayed to tell them if it is wrong or right. At the end of the test, everybody gets a score; it is the error rate of the third step.

Tests without menu. For the novice step, the user has the gesture image displayed by the side all the time. For the intermediate step, he should click on "Help" if he needs to see again the gesture image. His stroke will also be sent to the recognizer to be checked. For the final step, it works in the same way as the tests with the menu.

We present differences of these two kinds of tests for the three steps on Table 3 when the user is asked to execute the command "Australia".

Table 3. Three steps for the test with or without menu.

Australia	Novice step	Intermediate step		Expert step
With menus			 Stroke recognized: Australia 	
		Low initial speed	High initial speed	
Without menu			 Stroke recognized: Australia 	

Our goal is to emphasize the use of the menu, so we do not want any additional errors due to the recognizer's accuracy. So in addition to this experiment, we tested the recognizer's accuracy. We took all strokes collected on novice step of the tests without menu and we passed them to the recognizer. That's because users are not supposed to make error when they have the help by the side. The recognition rate obtained is 99.2%, proving that the gesture recognizer is efficient enough and should not introduce a bias in the evaluation.

3.3. Results and discussion

We compare the score obtained by each user in Figure 2. As explained before, the users from p1 to p6 (Group A) are those who began test1 without menu following by test2 with menus. Group B (p7-p12) have done the test in reverse order. For the two figures, the horizontal axis corresponds to the users' identity; the vertical axis reports the recognition rates for the tests.

To explain the figure 2(a), after a questionnaire, group A was happy to find menus for their test2 to help the memorization; the other realized the difficulty when there was no longer logic in the gestures. We notice also that there is no advantage for users of menus with respect to those without menu for test1. But when they passed to test2, a big improvement appeared for the users of menus. One bias between two tests is that people have never used this evaluation before and they are not used to it for test1. So the total average of test1 for the 12 users (0.76) is lower than the average of test2 (0.82).

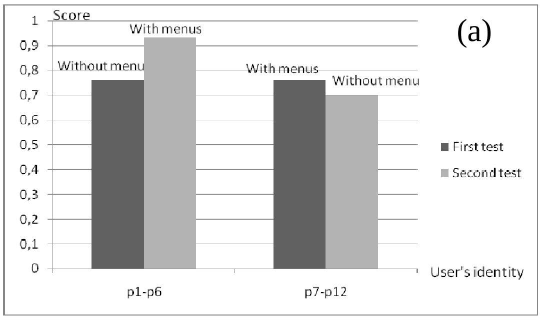


Figure 2(a). Success rate in group view. We observe that group A made a big progress from test1 to test2 with menus. Users were finally able to remember more than 90% of gestures. For group B, we notice a small decrease of recognition rate when they passed from test1 with menus to test2 without menu.

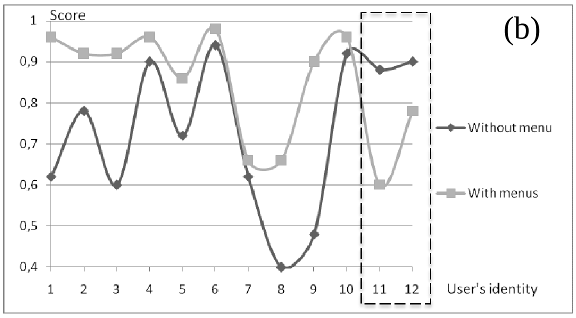


Figure 2(b). Success rate in individual view. We find out that all the persons who have begun test1 without menu obtained a better score when they did test2 with the menu. We also notice a strange better score for the eleventh and twelfth person when they passed from the test with menus to the test without menu.

To explain the two strange better scores in the figure 2(b), we suppose these people did not want to understand and remember the menu logic. They did not use the menus but rather the “Help” button during the intermediate step. Consequently, it became similar to the test without menu. Another reason is that even if we ask for 10 gestures, the users of menu can visualize 36 gestures (6 at each level), compared to the only gesture displayed for the test without menu, so it can be a little disturbing.

4. Conclusion & future work

We briefly introduced the Continuous Marking Menus and their novelties in this paper. The experiment for their evaluation proved that people can learn gestures more easily and quickly with the help of Continuous Marking Menus.

During the experience, some users told us that it was not easy to see the menu under their hand. This problem exists for every variant of marking menus in pen-based interface. Our next work is to resolve this question by changing usability of our menus to suit different users (left-hander or right-hander).

Even though these tests have proved the advantage to use our menu rather than a simple learning by heart of gestures, these tests are still a little shorter to demonstrate the implicit learning of gestures with menus. That’s why we will begin a cooperation work with researchers with strong background in experimental psychology in order to make the menu design and evaluation more meaningful.

References

Vuori, V. (2002). Adaptive Methods for On-Line Recognition of Isolated Handwritten Characters (Thesis).

Delaye, A., Sekkal, R. & Anquetil, E. (2010). Continuous Marking Menus for Learning Cursive Pen-based Gestures. *Proc. Int. Conf. on Intelligent User Interfaces – IUI’11*, Palo Alto, California (USA), February 13-16.

Bau, O. & Mackay, W.E. (2008). OctoPocus: A Dynamic Guide for Learning Gesture-Based Command Sets. *UIST’08*, Monterey, California (USA), October 19-22.

Bailly, G. (2009). Techniques de menus : Caractérisation, Conception et Evaluation (Thesis).

Zhao, S. & Balakrishnan, R. (2004). Simple vs. Compound Mark Hierarchical Marking Menus. *UIST’04*, Santa Fe, New Mexico (USA), October 24-27.

Zhao, S., Agrawala, M. & Hinckley, K. (2006). Zone and Polygon Menus: Using Relative Position to Increase the Breadth of Multi-Stroke Marking Menus. *CHI’06*, Montréal, Québec, Canada, April 22-27.

Rubine, D. (1991). Specifying gestures by examples. *Proc. of the 18th annual conference on Computer graphics and interactive techniques*, pages 329-337. ACM New York, NY, USA.

Willems, D., Niels, R., Van Gerven, M. & Vuurpijl, L. (2009). Iconic and multi-stroke gesture recognition. *Parrern Recognition, 42*.

Kurtenbach, G. & Buxton, W. (1993). The limits of expert performance using hierarchic marking menus. In *Proc. of INTERCHI’93*, page 487.